## REMARKS

### *Summary of Changes Made*

Claims numbering as high as 54 have at one point been pending in the Application, and claims 5-7, 20-27, 29-31, 39 and 41 were previously canceled, while claims 46-53 were withdrawn as drawn to non-elected inventions. No changes to the claims appear in this paper.

Accordingly, claims 1-4, 8-19, 28, 32-38, 40, and 42-54 (39 claims) remain pending, while all of the foregoing except claims 46-53 remain under consideration. No new matter is added by this amendment.

### *Error in Previous Amendment*

Applicants point out that an error was made in Amendment E as filed on 14 June 2010. The paragraph following Figure II should read as follows:

> On the other hand, when the melted metallic glass is cooled, it always cooled with passing through Tx. If the temperature slowly ~~rises~~ falls through the crystallization temperature, the melt is crystallized. In other words, if the metallic glass powder is heated to be melted and then cooled, the structure of the resulting coating is significantly affected by the cooling rate.

From the context of the discussion it should have been clear that a mention of the temperature **falling** (and not rising) was intended. It is believed that such error had little or no effect on prosecution, however such correction is presented for the Examiner's consideration.

### *Claim Rejections – 35 U.S.C. 112, First Paragraph*

Newly added claim 54 was rejected as failing to comply with the written description requirement. The Examiner believes claim 54 is not supported in the specification.

As pointed out in Amendment E, page 14, support for claim 54 is found in paragraph 50 of the specification. Applicants now also note that support for claim 54 is found in paragraph 114 of the specification.

Applicants respectfully request acknowledgement that the rejection is moot.

### *Claim Rejections – 35 U.S.C. 102 or 103 – (Branagan)*

Claims 1-4, 8-14, 17-19, 28, 40, and 42-45 are rejected under 35 U.S.C. 102(b) and/or 103(a) as anticipated and/or obvious in view of Branagan et al., XP-002556375, Wear-Resistant Amorphous and Nanocomposite Steel Coatings, ("Branagan").

Initially, Applicants wish to incorporate by reference all arguments made in the previous amendment (E) as if fully presented here, excepting the single error pointed out hereinabove.

Certain arguments are re-presented here for emphasis.

As previously explained, Branagan fails to disclose a thermal sprayed coating layer of a metallic glass of which the supercooled liquid temperature range ΔTx is 30 °C or more. Indeed, Branagan fails to clearly disclose a metallic glass.

In response to the Examiner's contention (p. 7, Office Action, 1 Sep 2010), that Branagan discloses a composition that "seems to be at least partially metallic glass," Applicants respectfully point out that "metallic glass" is not a conventional amorphous alloy. Metallic glass is different and distinguished from a conventional amorphous alloy. An alloy having a "glass" (or "amorphous") phase cannot always be called metallic glass. Indeed, metallic glass must exhibit a distinct glass transition at the glass transition temperature (Tg) and have a wide supercooled liquid temperature range (ΔTx) where ΔTx=Tx-Tg, before crystallization upon heating, Tx being the crystallization initiation temperature. A conventional amorphous alloy does NOT have Tg and ΔTx. See [0031]-[0032] of the specification (emphasis supplied):

> [0031] In recent years, alloys that have a relatively wide supercooled liquid temperature range and solidify to a glass phase (amorphous phase) through a supercooled liquid state even when the molten metal is cooled at relatively slow cooling rate of about 0.1-100 K/s were discovered. These alloys are called metallic glass or glass alloy, and they are distinguished from the conventional amorphous alloy.
>
> Metallic glass is defined as a metal alloy that is (1) ternary or more than ternary and <u>has a (2) wide supercooled liquid temperature range</u>. The metallic glass has an extremely high level of performance in properties including corrosion resistance and wear resistance, and the amorphous solid can be obtained by slow cooling. Lately, there is a view that the metallic glass is an aggregate of nanocrystals, and <u>it is considered that the fine structure of metallic glass in an amorphous state is different from an amorphous state of the conventional amorphous metal</u>.
>
> [0032] <u>Metallic glass is characterized by its exhibition of a distinct glass transition and a wide supercooled liquid temperature range, when it is heated, before crystallization</u>.
>
> When the thermal behavior of a metallic glass is examined with a DSC (differential scanning calorimeter), a broad wide endothermic band appears, with an increase in temperature, starting from the glass transition temperature (Tg) and then a sharp exothermic peak appears at the crystallization initiation temperature (Tx). Upon further heating, an endothermic peak appears at the melting point (Tm). Depending upon the metallic glass, respective temperatures are different. <u>The temperature region between Tg and Tx, namely, ΔTx=Tx-Tg, is the supercooled liquid temperature range. One characteristic of metallic glass is that ΔTx is 10-130 °C and it is very large.</u> The larger the ΔTx, the higher the stability of the supercooled liquid state with respect to

crystallization. In the case of the conventional amorphous alloy, this type of thermal behavior is not observed and ΔTx is approximately zero.

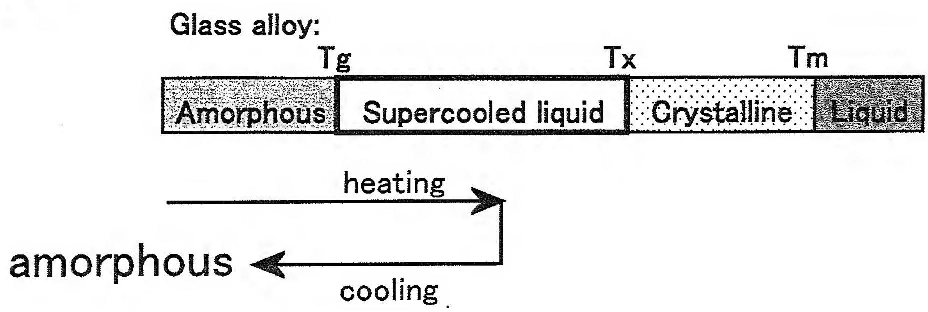
As extensively detailed in Amendment E filed 14 June 2010, Branagan's coatings (HVOF and plasma) do NOT exhibit both a Tg and ΔTx, and while are partially amorphous, are not metallic glass.

The examiner also said on page 8 of the Office Action that:

> It is also noted in Applicant's arguments that it is asserted that Fig. 9 of Branagan, the powder seems to have a Tg and Tx, but for both HVOF and plasma sprayed coating(s) do NOT have a Tg and ΔTx (page 12 of the present response). However, it is noted that the present invention desirably utilizes HVOF as a preferred coating method yet for some reason do have a Tg and TX unlike the prior art as asserted by Applicant. This argument is not persuasive since both teach HVOF as a suitable formation method and thus would both be expected to exhibit the same Tg and ΔTx properties." (emphasis added).

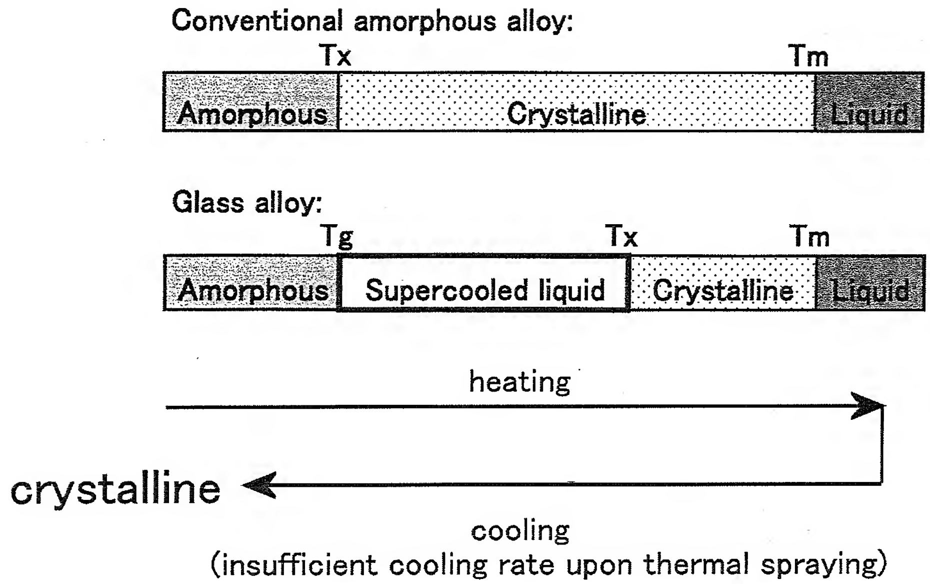
The reason why the coating of the present invention has a Tg and ΔTx (as opposed to the coatings of Branagan) is that the present invention differs from Branagan in terms of the thermal spraying. As noted in Amendment E, in the present invention, amorphous metallic glass powder (i.e., having ΔTx) is thermal sprayed at a temperature below the crystallization starting temperature (i.e., without being melted), which inevitably returns to the former amorphous metallic glass condition in the resulting coating. See Figure II of Amendment E, reproduced here:

**FIG-II:**



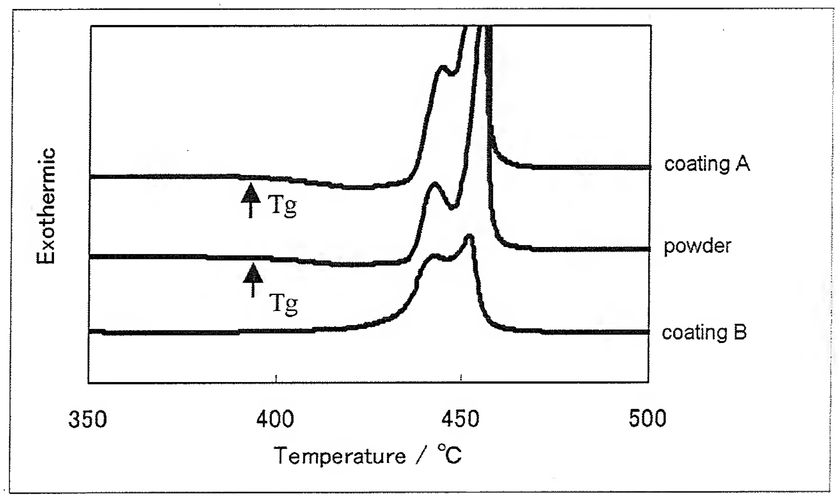

On the other hand, as in conventional thermal spraying, once the metallic powder is melted as shown in FIG-III of Amendment E, reproduced here,

**FIG-III:**




the composition and the structure is easily changed in the coating resulting from the starting powder, due to crystallization, oxidation, volatilization, etc., by high heat load and insufficient cooling rate through thermal spraying process. As explained in Amendment E, Branagan's coatings contain an amorphous phase but clearly lack Tg and $\Delta Tx$. Therefore, Branagan's coatings are no longer metallic glass due to the change of the composition and the structure through the thermal spraying. In fact, FIG-IV of Amendment E (reproduced here):

**FIG-IV:**




| | Tg | Tx |
|---|---|---|
| powder | 396.6°C | 436.2°C |
| coating A | 393.2°C | 436.7°C |
| coating B | N.D. | 433.1°C |

shows that the thermal spraying of metallic glass powder that is melted provides a coating that does not display a Tg or ΔTx. Thus, it is believed that in Branagan, amorphous metallic glass powder is thermal sprayed with being melted as usual and thus, Branagan's coatings do NOT have a Tg and ΔTx.

It is again hoped that the Examiner will consider the above arguments in reaching the conclusion that claims 1-4, 8-14, 17-19, 28, 40, and 42-45 are patentable over Branagan.

### *Claim Rejections – 35 U.S.C. 103 – (Branagan)*

Claims 15, 16, 32-38 and 54 are rejected under 35 U.S.C. 103(a) as obvious in view of Branagan.

With respect to these dependent claims, Applicants have amply demonstrated the patentability of the claims from which they depend, above. Examiner is respectfully requested to acknowledge the patentability of claims 15, 16, 32-38 and 54 on that basis.

**CONCLUSION**

In light of the foregoing, it is respectfully submitted that the present application, including claims 1-4, 8-19, 28, 32-38, 40, and 42-45, is in condition for allowance and notice to that effect is hereby requested. If it is determined that the application is not in a condition for allowance, the Examiner is invited to initiate a telephone interview with the undersigned attorney to expedite prosecution of the present application.

If there are any additional fees resulting from this communication, please charge the same to our Deposit Account No. 18-0160, our Order No. IWI-16783.

Respectfully submitted,

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